The effect of artificial night light on the abundance of nocturnal birds

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Abstract
Urbanisation is increasing rapidly, impacting on a broad range of species. The proliferation of electric light has transformed the night time environment; however, our understanding on the effects of artificial night lighting on fauna, including nocturnal birds, is extremely limited. The aim of this research was to determine whether artificial night light affected the abundance of nocturnal birds. Spotlighting surveys were undertaken in Research Park, Melbourne, Victoria, along three 300 m transects. Each transect was surveyed five times during three light treatments: when lights were on, 20 minutes after lights were turned off and when lights were absent, over a period of ten nights. A total of 123 nocturnal birds was detected during survey nights. Two species were recorded — the Southern Boobook *Ninox novaeseelandiae* and the Tawny Frogmouth *Podargus strigoides*. The Tawny Frogmouth was detected along all three transects (n=121); however, the Southern Boobook was detected along one transect only (n=2). None of the light treatments had a significant effect on bird abundance. Neither did location, habitat or the combined effects of light treatments, location and habitat. The results of this research will contribute to a growing body of knowledge and support future conservation activities for species in areas undergoing urbanisation. (*The Victorian Naturalist* **127** (5) 2010, 192-195).

Keywords: Tawny Frogmouth, urbanisation, Southern Boobook

Introduction

The transformation of natural environments to urban use, and the resulting effects on fauna, have been examined widely, including the effects of habitat fragmentation (Antos and White 2004; Parris 2006), human disturbance (Bosakowski *et al.* 1993; Slabbekoorn and Peet 2003), and modification of habitats (Walsh *et al.* 2001; Cooke *et al.* 2006). The impact of artificial night light on nocturnal birds, however, is poorly understood.

The proliferation in both *type* and *use* of electric light has, in recent times, transformed the night environment over a substantial portion of the earth's surface (Longcore and Rich 2004). The implications of this transformation on faunal species is yet to be fully understood (Rich and Longcore 2006).

Longcore and Rich (2004) use the term *light pollution* to describe the degradation of views of the night sky. They also describe artificial light sources that alter the natural patterns of ecosystems as *ecological light pollution*. These include direct glare from temporary, unexpected fluctuations in lighting and increased illumination from sources such as lighted buildings, towers and streetlights.

In natural settings, ecological light pollution has demonstrable effects on both the population and behavioural ecology of a range of species. Increased illumination enables some diurnal species to extend their foraging activities into the night time (Zhou *et al.* 1998; Negro and Bustamante 2000). For some nocturnal species, increased illumination enhances prey availability (Blake *et al.* 1994). Conversely, for a number of species, particularly those adapted to navigating in dark environments, the presence of night lighting can be disorienting, resulting in high levels of mortality (Salmon *et al.* 1995; Jones and Francis 2003).

Some species of nocturnal birds are advantaged by increased illumination, either natural or artificial, resulting in increased predation opportunities (Bouskila 1995) and higher levels of hunting success (Clarke 1983). Our understanding of the full range of ecological consequences of artificial night lighting on species, including nocturnal birds, however, is still very limited. As many areas continue to undergo rapid urbanisation, further research is required to ensure that current, and future, conservation activities take into consideration the effects of artificial night light on both diurnal and nocturnal species. The aim of the study is to determine whether artificial night light affects the abundance of nocturnal birds, in three ways:

1. with the presence of artificial night light;
2. in the absence of artificial night light;
3. 20 minutes after artificial night light is turned off.

Methods

Site description

Research Park is located in Research, a suburb within the Shire of Nillumbik, Melbourne, Victoria. The park is approximately 5 ha in size and surrounded by residential development on three of its four sides, with the fourth side bordered by a main road. Park vegetation consists of small pockets of high quality remnant bushland surrounded by parkland containing a high number of weed species. The park is used for a range of recreational purposes and contains a football oval and six tennis courts. Both the oval and tennis courts are lit for night use throughout the year on all weeknights and most weekends, with duration of lighting varying for both.

Lights used by both the football club and tennis courts are metal haloid type and vary between 1000 and 2000 w. All lights are positioned to ensure that glare is directed inwards onto the courts and oval but residual light glare extends approximately 20 m into the surrounding bush and parkland from the outer perimeter of both the oval and the courts.

Survey techniques

Three lines of transect, each of 300 m in length, were located on the outer boundary of the region of light glare along three of the four boundaries of the park. Transect one was located adjacent to three of the six tennis courts in an area containing a number of large living *Eucalyptus* trees. Transect two was located within a strip of high quality remnant bushland and transect three was located in a section of the park containing both living and dead, scattered, large, *Eucalyptus* and *Corymbia* trees.

During August 2007, spotlighting was undertaken along transects and extended into the edge of the oval and tennis courts to survey for nocturnal bird species. Each transect was surveyed five times during nights when:- (1) lights were turned on; (2) 20 minutes after the lights were turned off (on the same night) and (3) lights had not been used at all.

During surveys, all species of nocturnal birds detected were recorded by experienced observers. Survey times differed considerably throughout the research period due mainly to time factors associated with light treatments.

Statistical analysis

Data were analysed with the statistical package SPSS using a multi-factor ANOVA test to determine whether bird abundance was affected by the three light treatments, whether the location of transects and habitat had an effect on abundance levels, and whether there was an interaction between the location of transects and the three light treatments on overall bird species abundance.

Results

A total of 123 nocturnal bird sightings was detected during the ten survey nights. Two species were recorded over the survey period, the Southern Boobook *Ninox novaeseelandiae* and the Tawny Frogmouth *Podargus strigoides* (Table 1.). The Tawny Frogmouth was detected in all three transects (n=121); however, the Southern Boobook was detected along only one transect (n=2).

None of the light treatments had a significant effect on bird numbers ($F=232$, $df=2,36$, $p>0.05$). The location of, and habitat contained within transects did not have a significant effect on bird numbers ($F=133$, $df=2,36$, $p>0.05$). There was no significant interaction between transect location and the three light treatments on overall bird species abundance ($F=2.105$, $df=4,36$, $p>0.05$) (Fig. 1).

Discussion

Overall, the highest number of sightings was recorded in transect one. This transect also had the highest number of sightings during the 'lights on' and '20 minutes after lights off' treatments. The presence of the artifical light source may have accounted for the high number of sightings detected along transect one. For both the Tawny Frogmouth and Southern Boobook, invertebrates comprise a significant proportion of their diet (Rose and Eldridge 1997; Penck and Queale 2002). Even during cooler survey nights, high numbers of flying invertebrates were observed clustering around the lights at this transect during the lights on period. Artifical light can act as an attractant for invertebrates (Frank 1988), and as a factor influencing invertebrate activity and abundance levels (Kamm 1973; Fordyce *et al.* 2006).

Table 1. Number of birds recorded in transects during all three light treatments (n=123).

Transects	Lights on	20 minutes after lights off	Lights absent
1	19	15	9
2	15	12	12
3	10	13	18
Totals	44	40	39

Light-attracted invertebrates have been an important prey source for several species including the Western Burrowing Owl *Athene cunicularia hypugea*. Increased prey availability, and enhanced foraging success have been contributing factors to the species' reproductive success in an urban environment (Botelho and Arrowood 1996). The abundance of light-attracted invertebrate prey also has been an important factor in the establishment and the long-term survival of a colony of Lesser Kestrels *Falco naumanni* in a highly urbanised city in Spain (Negro and Bustamante 2000).

Other factors also may have contributed to the high number of nocturnal birds detected at this transect. These include the presence of mature, but not locally indigenous, rough barked *Eucalyptus* species, which Tawny Frogmouths are known to prefer as perching and roosting sites, (Kortner and Geiser 1999), and the proximity of streetlights, which may have encouraged the birds to remain in the area to forage after the focus lighting had been turned off (Hobbs 1961; Rose and Eldridge 1997).

Irrespective of the survey time (sometimes as late as 11 pm), birds were seen actively foraging and changing perch sites in the vegetation around transect one. During the cooler winter months, when food resources are generally low, Tawny Frogmouths are known to enter torpor as a strategy to conserve energy (Kortner *et al.* 2001). This strategy also occurs in several other caprimulgiform birds. Night torpor bouts in Tawny Frogmouths last, on average, for up to seven hours after a short activity period around dusk and just before sunrise (Kortner *loc. cit.*). The combined effects of additional food resources and increased foraging success may be triggering a delay in the birds' torpor period, enabling them to take full advantage of an increased food resource at a time when resource abundance for these birds is traditionally low.

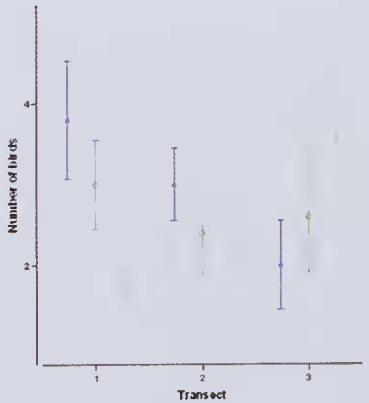

Fig. 1. Number of birds recorded in August 2007 in transects during three light treatments Δ = lights on, 0 = 20 minutes after lights off and ❑= light absent.

Transect two recorded the second highest number of birds during the light absent treatment. All birds were located perched in trees on the edge of the remnant closest to the light source, but were not observed hunting for prey at this transect.

The high number of birds recorded along transect three during all three light treatments was unexpected, particularly during the lights absent treatment (n=18). Similar to transect one, factors including bright street lighting and the availability of vegetation for foraging activities, may have contributed to this result.

Research constraints

The results presented here were subject to a range of limitations, including changed lighting times, fluctuating light intensities, space constraints for transects and the short duration of the study, conducted during one month of winter. While not statistically significant, the data and observations from this study indicate that there may be biological importance in the results obtained. Further research is required to determine if these results represent a trend or a random occurrence.

Conclusion

While urbanisation can have negative consequences for many species (Chase and Walsh 2006), there are others that appear to be adapt-

ing to, and occupying, urban and suburban environments with some success (Low 2002). Urban light sources are a prominent feature of urban environments. Their prey attracting capacity may support the occupation of some species in urban environments.

The presence of the Tawny Frogmouth in Research Park has been noted by the local friends group during surveys over the past decade. Results indicate that numbers appear to remain high and consistent from year to year (Joy Pagon pers. comm. 2007). The Tawny Frogmouth is neither a hollow-dependent species nor reliant on any one particular prey source. (Kortner and Geiser 1999; Kaplan 2007). Generalist habitat requirements combined with an unseasonal and abundant food source may be factors contributing to its continuing occupation of Research Park.

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